AMENDMENT TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently Amended) A recursive discrete Fourier transformation method wherein data values x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1), x(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency component, which is degree k (k is 0 or a positive integer smaller than N) obtained by carrying out complex Fourier transformation on the data stream, is obtained such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using data value x(t+N) supplied at time t+N, data value x(t) stored in the first memory means temporarily and the complex Fourier coefficients Xr(k, t), Xi(k,t) stored in the second memory means temporarily, obtaining complex Fourier coefficients Xr(k, t+1) and Xi(k, t+1) to the data stream supplied since time t+1 with respect to a positive constant value A for giving an amplitude value corresponding to a difference between the x(t+N) and the x(t) according to a following equation:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{A}[x(t+N)-x(t)]\right\}\times\cos\left[2\frac{\pi k}{N}\right]+X_i(k,t)\sin\left[2\frac{\pi k}{N}\right]$$

$$X_i(k,t+1)=X_i(k,t)\cos\left[2\frac{\pi k}{N}\right]-\left\{X_r(k,t)+\frac{1}{A}[x(t+N)-x(t)]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

2. (Canceled)

3. (Canceled)

4. (Currently Amended) A recursive discrete Fourier transformation method wherein with sampling frequency as fs, data values x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1), x(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency interval given with a minimum frequency f1 and a maximum frequency f2 to the data stream is regarded as a measuring frequency interval, a frequency interval obtained by dividing that measuring frequency interval by the N is assumed to be an analysis frequency interval and a result of the frequency analysis obtained by carrying out complex Fourier transformation at every analysis frequency interval is obtained as a frequency component which is k (k is 0 or a positive integer smaller than N) times the frequency interval, such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using data value x(t+N) supplied at time t+N, data value x(t) stored in the first memory means temporarily and the complex Fourier coefficients Xr(k, t), Xi(k,t) stored in the second memory means temporarily, obtaining complex Fourier coefficients Xr(k, t+1) and Xi(k, t+1) within the frequency interval with the minimum frequency f1 and the maximum frequency f2 to the data stream supplied since time t+1 with respect to a positive constant A for giving an amplitude corresponding to a difference between the x(t+N) and the x(t) according to following equations:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{A}[x(t+N)-x(t)]\right\}\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$
$$+X_i(k,t)\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$
$$X_i(k,t+1)=X_i(k,t)\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}-\left\{X_r(k,t)+\frac{1}{A}[x(t+N)-x(t)]\right\}$$
$$\times\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

5. (Canceled)

6. (Canceled)

7. (Currently Amended) A recursive discrete Fourier transformation method wherein data values x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1), x(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency component, which is degree k (k is 0 or a positive integer smaller than N) obtained by carrying out complex Fourier transformation on the data stream, is obtained such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using the complex Fourier coefficients Xr(k, t) - jXi(k, t) stored in the second memory means temporarily, obtaining complex Fourier coefficients Xr(k, t+1) - jXi(k, t+1) to the data stream supplied since time t+1 based on a transfer function expressed in a following equation.

$$H(z) = A\left(1 - z^{-N}\right)\left\{\frac{\cos\left[2\frac{\pi k}{N}\right] - j\sin\left[2\frac{\pi k}{N}\right] - z^{-1}}{1 - 2\cos\left[2\frac{\pi k}{N}\right]z^{-1} + z^{-2}}\right\}$$

where A is a positive constant for providing [x(t+N) - x(t)] with an amplitude.

8. (Canceled)

9. (Canceled)

10. (Currently Amended) A recursive discrete Fourier transformation method wherein with sampling frequency as fs, data values x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1), x(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency interval given with a minimum frequency f1 and a maximum frequency f2 to the data stream is regarded as a measuring frequency interval, a frequency interval obtained by dividing that measuring frequency interval by the N is assumed to be an analysis frequency interval and a result of the frequency analysis provided by carrying out complex Fourier transformation at every analysis frequency interval is obtained as a frequency component which is k (k is 0 or a positive integer smaller than N) times the frequency interval, such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream x(t), x(t+1), x(t+2), x(t+3), ..., x(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t+1) - jXi(k, t+1) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t+1) - jXi(k, t+1) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using the complex Fourier coefficient Xr(k, t) - jXi(k, t) stored in the second memory means temporarily, obtaining complex Fourier coefficients Xr(k, t+1) - jXi(k, t+1) at the frequency interval given by the minimum frequency f1 and the maximum frequency f2 to the data stream supplied since time t+1 based on a transfer function expressed in a following equation:

$$H(z)=A\left(1-z^{-N}\right)\left\{\frac{\cos\left[2\pi\ p\right]-j\sin\left[2\pi\ p\right]-z^{-1}}{1-2\cos\left[2\pi\ p\right]z^{-1}+z^{-2}}\right\}$$

where A is a positive constant for providing [x(t+N) - x(t)] with an amplitude value, and

$$p=\frac{1}{fs}\left\{\frac{(f2-f1)k}{N-1}+f1\right\},\quad 0\leq k\leq N-1$$

11. (Canceled)

12. (Canceled)

13. (Currently Amended) A recursive discrete Fourier transformation method for obtaining complex Fourier coefficients, wherein data values xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency component, which is degree k (k is 0 or a positive integer smaller than N) obtained by carrying out complex Fourier transformation on the data stream, is obtained such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using the data value xr(t+N) + jxi(t+N) supplied at time t+N, the data value xr(t) + jxi(t) stored in the first memory means temporarily and the complex Fourier coefficient Xr(k, t) and Xi(k, t) stored in the second memory means temporarily and used recursively, obtaining complex Fourier coefficients Xr(k, t+1) and Xi(k, t+1) to the data stream supplied since time t+1 with respect to a positive constant A for giving an amplitude value corresponding to the difference between the xr(t+N) and the xr(t) according to a following equation:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{A}[x_r(t+N)-x_r(t)]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$-\left\{X_i(k,t)+\frac{1}{A}[x_i(t+N)-x_i(t)]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

$$X_i(k,t+1)=\left\{X_i(k,t)+\frac{1}{A}[x_i(t+N)-x_i(t)]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$+\left\{X_r(k,t)+\frac{1}{A}[x_r(t+N)-x_r(t)]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

14. (Original) A recursive discrete Fourier transformation method according to claim 13 wherein by using data value yr(t) + jyi(t) supplied at time t, data value yr(t+N) + jyi(t+N) supplied at time t+N and complex inverse discrete Fourier coefficients Yr(k, t) and Yi(k, t) with the real part and the imaginary part obtained with respect to N data values yr(t) + jyi(t), yr(t+1) + jyi(t+1), ..., yr(t+N-1) + jyi(t+N-1) supplied from time t to time t+N-1,

a real part Yr(k, t+1) and an imaginary part Yi(k, t+1) of each complex inverse discrete Fourier coefficient of N data values supplied since time t+1 are obtained with respect to a positive constant value B for giving an amplitude corresponding to a difference between the yr(t+N) and the yr(t) as inverse discrete Fourier transformation data, according to following equations,

$$Y_r(k,t+1)=\left\{Y_r(k,t)+\frac{1}{B}\left[y_r(t+N)-y_r(t)\right]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$+\left\{Y_i(k,t)+\frac{1}{B}\left[y_i(t+N)-y_i(t)\right]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

$$Y_i(k,t+1)=\left\{Y_i(k,t)+\frac{1}{B}\left[y_i(t+N)-y_i(t)\right]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$-\left\{Y_r(k,t)+\frac{1}{B}\left[y_r(t+N)-y_r(t)\right]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

and after the obtained inverse discrete Fourier transformation data is supplied, discrete Fourier transformation on the supplied inverse discrete Fourier transformation data is carried out,

the recursive discrete Fourier transformation conducting discrete Fourier transformation by using the positive constant value A corresponding to the positive constant value B.

15. (Canceled)

16. (Currently Amended) A recursive discrete Fourier transformation method for obtaining complex Fourier coefficients, wherein with sampling frequency as fs, data values xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N complex data values supplied since time t as a data stream, a frequency interval given with a minimum frequency f1 and a maximum frequency f2 to the data stream is regarded as a specified frequency interval, a frequency interval obtained by

dividing the specified frequency interval by the N is assumed to be a minimum frequency interval and a result of the Fourier transformation provided by carrying out complex Fourier transformation at every minimum frequency interval is obtained as a frequency component which is k (k is 0 or a positive integer smaller than N) times the minimum frequency interval, such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are complex Fourier coefficients, the method comprising:

a first step of storing the data stream xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ <u>a</u> second memory means temporarily; and

a fourth step of by using the data value xr(t+N) + jxi(t+N) supplied at time t+N, the data value xr(t) + jxi(t) stored temporarily in the first memory means and complex Fourier coefficients Xr(k, t) and Xi(k, t) stored temporarily in the second memory means and used recursively, obtaining complex Fourier coefficient Xr(k, t+1) and Xi(k, t+1) in the specified frequency interval given by the minimum frequency f1 and the maximum frequency f2 to the data stream supplied since time t+1 with respect to a positive constant A for giving an amplitude value corresponding to a difference between the x(t+N) and the x(t) according to a following equation:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{A}\left[x_r(t+N)-x_r(t)\right]\right\}\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$-\left\{X_i(k,t)+\frac{1}{A}\left[x_i(t+N)-x_i(t)\right]\right\}\times\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$X_i(k,t+1)=\left\{X_i(k,t)+\frac{1}{A}\left[x_i(t+N)-x_i(t)\right]\right\}\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$+\left\{X_r(k,t)+\frac{1}{A}\left[x_r(t+N)-x_r(t)\right]\right\}\times\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

17. (Original) A recursive discrete Fourier transformation method according to claim 16 wherein by using data value yr(t) + jyi(t) supplied at time t, data value yr(t+N) + jyi(t+N) supplied at time t+N and complex inverse discrete Fourier coefficients Yr(k, t) and Yi(k, t) with the real part and the imaginary part obtained with respect to N data values yr(t) + jyi(t), yr(t+1) + jyi(t+1), ..., yr(t+N-1) + jyi(t+N-1) supplied from time t to time t+N-1,

a real part Yr(k, t+1) and an imaginary part Yi(k, t+1) of each complex inverse discrete Fourier coefficient of N data values supplied since time t+1 are obtained with respect to a positive constant value B for giving an amplitude corresponding to a difference between the yr(t+N) and the yr(t) as inverse discrete Fourier transformation data, according to following equations,

$$Y_r(k,t+1)=\left\{Y_r(k,t)+\frac{1}{B}\left[y_r(t+N)-y_r(t)\right]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$+\left\{Y_i(k,t)+\frac{1}{B}\left[y_i(t+N)-y_i(t)\right]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

$$Y_i(k,t+1) = \left\{Y_i(k,t) + \frac{1}{B}\left[y_i(t+N) - y_i(t)\right]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$-\left\{Y_r(k,t) + \frac{1}{B}\left[y_r(t+N) - y_r(t)\right]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

and after the obtained inverse discrete Fourier transformation data is supplied, discrete Fourier transformation on the supplied inverse discrete Fourier transformation data is carried out,

the recursive discrete Fourier transformation conducting discrete Fourier transformation by using the positive constant value A corresponding to the positive constant value B.

18. (Canceled)

19. (Currently Amended) A recursive inverse discrete Fourier transformation method for obtaining complex inverse Fourier coefficients wherein complex data values xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, an inverse complex Fourier transformation component, which is degree k (k is 0 or a positive integer smaller than N) obtained by carrying out inverse complex Fourier transformation on the data stream, is obtained such that a real part Xr(k, t) thereof and an imaginary part Xi(k, t) thereof are inverse complex Fourier coefficients, the method comprising:

a first step of storing the data stream xr(t)+jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1) supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the inverse complex Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the inverse complex Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ a second memory means temporarily; and

a fourth step of by using the data value xr(t+N) + jxi(t+N) supplied at time t+N, the data value xr(t) + jxi(t) stored in the first memory means temporarily and the inverse complex Fourier coefficient Xr(k, t) and Xi(k, t) stored in the second memory means temporarily, obtaining inverse complex Fourier coefficients Xr(k, t+1) and Xi(k, t+1) to the data stream supplied since time t+1 with respect to a positive constant B for giving an amplitude value corresponding to the difference between the xr(t+N) and the xr(t) according to a following equation:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{B}[x_r(t+N)-x_r(t)]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$+\left\{X_i(k,t)+\frac{1}{B}[x_i(t+N)-x_i(t)]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

$$X_i(k,t+1)=\left\{X_i(k,t)+\frac{1}{B}[x_i(t+N)-x_i(t)]\right\}\cos\left[2\frac{\pi k}{N}\right]$$

$$-\left\{X_r(k,t)+\frac{1}{B}[x_r(t+N)-x_r(t)]\right\}\sin\left[2\frac{\pi k}{N}\right]$$

20. (Canceled)

21. (Currently Amended) A recursive inverse discrete Fourier transformation method for obtaining complex inverse Fourier coefficients wherein with sampling frequency as fs, data values xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N) sampled at times t, t+1, t+2, t+3, ..., t+N-1, t+N (N is a positive integer which is 1 or more) each having an equal interval are supplied and with such N data values supplied since time t as a data stream, a frequency interval given with a minimum frequency f1 and a maximum frequency f2 to the data stream is regarded as a specified frequency interval, a frequency interval obtained by dividing that specified frequency interval by the N is assumed to be a minimum frequency interval and a result of the inverse Fourier transformation provided by carrying out inverse complex Fourier transformation at every minimum frequency interval is obtained as a frequency component which is k (k is 0 or a positive integer smaller than N) times the minimum frequency interval, in the form of a real part Xr(k, t) and an imaginary part Xi(k, t), the method comprising:

a first step of storing the data stream xr(t) + jxi(t), xr(t+1) + jxi(t+1), xr(t+2) + jxi(t+2), xr(t+3) + jxi(t+3), ..., xr(t+N-1) + jxi(t+N-1), xr(t+N) + jxi(t+N)supplied since time t at time t+N-1 into a first memory means temporarily;

a second step of obtaining the inverse Fourier coefficients Xr(k, t) and Xi(k, t) of the data stream stored temporarily at the first step;

a third step of storing the inverse Fourier coefficients Xr(k, t) and Xi(k, t) obtained at the second step into ~~the~~ <u>a</u> second memory means temporarily; and

a fourth step of by using the data value xr(t+N) + jxi(t+N) supplied at time t+N, the data value xr(t) + jxi(t) stored temporarily in the first memory means and preceding inverse Fourier coefficients Xr(k, t) and Xi(k, t) stored temporarily in the second memory means, obtaining inverse Fourier coefficient Xr(k, t+1) and Xi(k, t+1) in the specified frequency interval given by the minimum frequency f1 and the maximum frequency f2 to the data stream supplied since time t+1 with respect to a positive constant B for giving an amplitude value corresponding to a difference between the x(t+N) and the x(t) according to following equations:

$$X_r(k,t+1)=\left\{X_r(k,t)+\frac{1}{B}\left[x_r(t+N)-x_r(t)\right]\right\}\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$+\left\{X_i(k,t)+\frac{1}{B}\left[x_i(t+N)-x_i(t)\right]\right\}\times\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$X_i(k,t+1)=\left\{X_i(k,t)+\frac{1}{B}\left[x_i(t+N)-x_i(t)\right]\right\}\times\cos\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

$$-\left\{X_r(k,t)+\frac{1}{B}\left[x_r(t+N)-x_r(t)\right]\right\}\times\sin\left\{2\frac{\pi}{fs}\left[\frac{(f2-f1)k}{N-1}+f1\right]\right\}$$

22. (Canceled)